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Cycling of uranium series radionuclides in a freshwater pond

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Abstract

The distribution of uranium series radionuclides, namely ^{238}U, ^{234}U, ^{230}Th, ^{226}Ra, ^{210}Pb, ^{210}Po, and ^{232}Th was investigated in a freshwater ecosystem in a pond naturally formed decades ago in the open pit of a former uranium mine. The pond is rain fed and contains about 330x10^{3} m^{3} of water and has a maximum depth of 20 meters. The uranium series radionuclides in the bedrock were dissolved and displayed stable water concentrations over time. Radionuclide activity concentrations were determined in the surface, mid depth, and near-bottom water, and in sediment, plankton, aquatic plants and fish. Concentrations of dissolved ^{238}U in the surface water were 20.2 and 15.7 Bq/L in surface and in bottom water, while ^{226}Ra displayed the opposite trend with 50 and 495 mBq/L in the same samples. ^{210}Pb and ^{210}Po concentrations in the soluble phase were also higher near the bottom than at the pond surface. Bottom water was nearly anoxic and the sediment accumulated in the deepest zone of the pond was organic matter rich and reducing. The microscopic phytoplankton was abundant in the surface water layer and biogenic particles carry radionuclides from the pond upper layer to the bottom sediment. This bottom sediment was much enriched in radionuclides, particularly in ^{230}Th and ^{210}Pb-^{210}Po, in comparison with sediment from the pond shoreline. Radionuclide accumulation in biota was investigated and concentration factors are reported and compared with those in the literature, when available. For example, in the muscle of the planktivorous carp (*Cyprinus carpio*), ^{238}U, ^{226}Ra and ^{210}Po concentrations were determined, respectively, at 2.9, 2.2 and 61 Bq/kg (wet weight), showing a strong concentration of ^{210}Po in comparison with other radionuclides. Computed concentration factors for these radionuclides in the carp muscle were respectively 7, 44 and 2.2x10^{3}. This paper gives a contribution to expand current knowledge

on the cycling and bioaccumulation of uranium series radionuclides in freshwater ecosystems.